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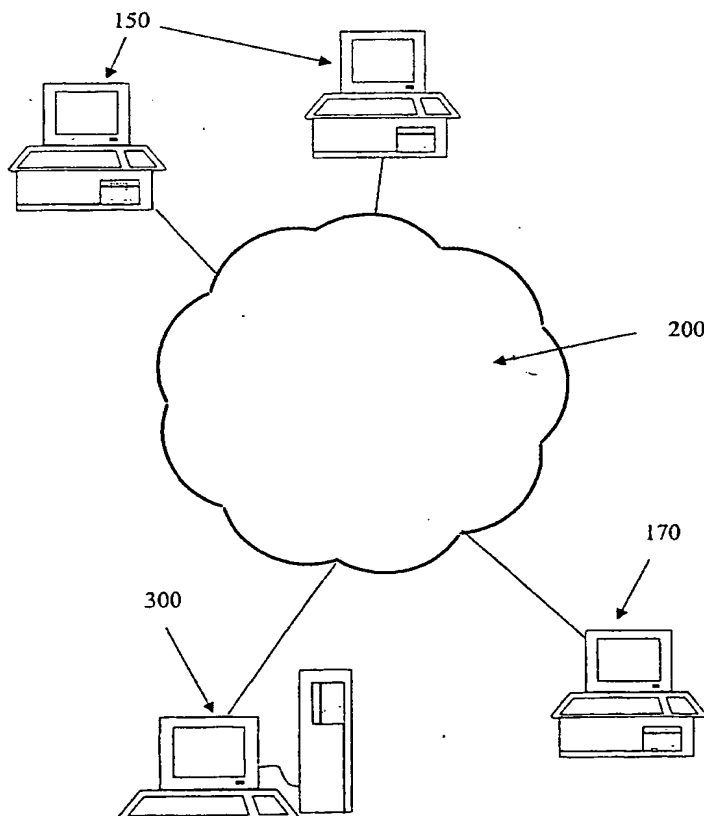
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(54) Title: **METHOD TO ASSESS THE QUALITY OF A VOICE COMMUNICATION OVER PACKET NETWORKS**



(57) Abstract: The present invention provides a test method which can determine whether a user terminal is capable of supporting a real time connection, such as a computer telephony link, with a network terminal whilst simultaneously supporting a connection with a WWW server.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD TO ASSESS THE QUALITY OF A VOICE COMMUNICATION OVER PACKET NETWORKS

This invention relates to a test method which can be used to determine whether multiple communications links can be supported by a user terminal.

5 Conventional telephony services are based upon the provision of a dedicated circuit to connect two telephony users via an exchange. The set-up and maintenance of the circuit have an associated cost, but the dedicated circuit allows a guaranteed quality of service (QoS) for the telephony service provided over the circuit. In contrast, computer communications made over packet based networks do
10 not involve the set-up and maintenance of a circuit, but instead a stream of packets are routed from one computer to a second computer. The route taken by consecutive packets, may vary according to changes in network performance, congestion, etc. One of the disadvantages of packet-based networks when compared with circuit-based networks is that there is no guarantee that all of the
15 packets transmitted by a computer will arrive at the destination computer or that those packets that are received by the destination computer will arrive in the same order that they were transmitted. Packets can be re-transmitted following a prompt by the destination computer and the application should be capable of re-ordering the received packets into the correct sequence and these steps are of little consequence
20 if the data being transmitted between the computers does not have any time dependence., for example a file transfer, the transmission of an email message, etc. However, if the computers are transmitting real-time data, such as telephony or audio-visual signals for example, then the reception of out of sequence packets and the failure to receive some packets in time, or not at all, may cause significant
25 problems with the playback of the real-time data.

Despite these disadvantages, it is perceived that in the near future most high capacity communications networks will be packet-based networks which will carry all forms of data, including real-time data such as speech and video. It is currently possible to use the public Internet to carry telephony services (often referred to as
30 computer telephony (CT), PC telephony, Internet telephony or voice over IP (VoIP)) but the relatively low bandwidth available to Internet users means that such services tend to be of low quality.

According to a first aspect of the invention there is provided a method of operating a communications network, the communications network comprising one or more network data stores, one or more network terminals and a plurality of user terminals, the method comprising the steps of: (a) establishing a first communications link between a user terminal and a first network terminal via said communications network; (b) establishing a test link between the user terminal and a second network terminal via said communications network; (c) transmitting a test signal over said test link; (d) measuring the received test signals to determine the capacity of said test link; and (e) establishing a communications link between the user terminal and the network terminal via said communications network in accordance with the result of step (d). Preferably the test link established in step (b) is a computer telephony link between the user terminal and the network terminal and the test signal comprises speech or speech fragments. The communications link between the user terminal and the network terminal established in step (e) may be a computer telephony link.

According to a second aspect of the invention there is provided a data carrier containing computer code for loading into a computer for the performance of any of the methods as described

The invention will now be described, by way of example only, with reference to the following figures in which;

Figure 1 shows a functional block diagram of a computer telephony terminal;

Figure 2 shows a schematic depiction of computer telephony terminals connected to a communications network; and

25

Figure 1 shows a functional block diagram of a computer telephony terminal. The computer telephony terminal is implemented as a computer. The computer includes a central processing unit, memory and storage devices and various hardware devices such as a display unit and a keyboard. The computer has an operating system (indicated by reference numeral 100 in Figure 1) stored in the memory and storage devices. Software applications such as a word processor application and an Internet browser may also be stored in the memory and storage devices and run under the operating system. As will now be described with

reference to Figure 1, the computer includes a software application and hardware to provide it with the functionality of a computer telephony terminal. As shown in Figure 1, the computer telephony terminal includes a computer telephony (CT) software application 10, which is a process that is run under the computer operating system 100. The CT application is used to establish a communication link with a CT application which is being run on a second computer, which is connected to the first computer via a communications network (see Figure 2). It is also possible for the CT application to communicate with a standard telephone which is connected to the PSTN (public switched telephony network) if there is a suitable gateway from the communications network to the PSTN. Additionally, the CT application may communicate with a so-called 'internet phone' which has the appearance and functionality of a conventional telephone but instead of connecting to, and communicating via, the PSTN such 'internet phones' are connected to the communication network and provide the same functionality as a computer running a CT application but at much reduced cost and complexity (see *"Voice-Data Convergence and the Corporate Voice-Over-IP Trial"*, A Catchpole, IBTE Journal, volume 17, part 4, January 1999, pages 218-224).

The CT application 10 communicates with a CT application in another CT terminal, e.g. a personal computer or internet phone, by sending and receiving data transmission packets, the data packets containing short segments of speech. The CT application 10 communicates with the computer's soundcard 20, which is connected to a microphone 21 and a loudspeaker(s) 22 (the microphone and loudspeaker(s) may be integrated and take the form of a headset or a conventional telephony handset). The user's voice signal is captured by the microphone 21 and then the soundcard converts the analogue signal supplied by the microphone into digital voice data. This digital voice data is then sent to the CT application, which may perform some form of data modulation or compression in order to increase the efficiency of the data transmission across the network before the digital voice data is arranged into packets of a suitable size (either in terms of the number of bytes of the package or in terms of the length of speech that is represented by the digital voice data). These voice data packets are sent to the communications interface 30 such that the voice data therein may be transmitted to the destination terminal. The communications interface 30 may be a modem or terminal adaptor for remote

access to a packet-based network or it may be a network card for direct access to a packet-based network. The communications interface places the voice data packets within the payload of the data transmission packets used by the communications interface, for example TCP (Transmission Control Protocol), UDP (User Datagram
5 Protocol), etc. The data transmission packets are then routed across the communications network (see Figure 2) to the destination terminal, where the analogue speech signal is recovered in a manner described below.

The communications interface 30 receives data transmission packets that have been sent to the computer and differentiates the data transmission packets by
10 their content, for example part of a stream of computer telephony packets, a WWW download, an email message, etc. For CT data, the voice data packets are extracted from the payload of the data transmission packets and are then sent to the CT application 10. The CT application processes the voice data packets, ordering them in the correct sequence and demodulating (and/or decompressing) the
15 data as necessary so that a stream of digital voice data can be sent to the soundcard 20, which converts the data from a digital signal to an analogue signal, which can then be played back to the user through the loudspeaker(s) 22.

The soundcard provides functionality using both hardware 28, which interfaces with the external hardware (loudspeakers, microphone, etc.) and the
20 internal bus of the computer, and software drivers 25 stored in a memory device, which may be mounted on the soundcard, which allow the operating system and the applications running on the computer to access functions that cause the hardware to respond accordingly.

Test application 50 is a software process which is also running under the
25 computer operating system in parallel with the CT application 10 and any other software applications. The test application 50 interfaces with the soundcard drivers 25 so that test signals can be injected into the digital voice data before it is passed to the CT application for onward transmission. Similarly, the test application 50 can extract test signals from received digital voice data that have been passed from the
30 CT application to the soundcard and analyse the extracted test signals in order to determine the transmission quality.

If non-intrusive test methods are being used, i.e. if only the spectral properties of the received speech signals are being analysed, then no test signals need be injected into the digital voice data packets and the test application needs to take a copy of the digital voice data that has been sent from the CT application to the soundcard. When two computers, each arranged as shown in Figure 1, are connected to a communications network, and a telephony link is established between the computers, it is possible to measure the quality of the telephony link. More specifically, the test application in one computer can cause test signals to be injected into voice data packets generated by the CT application, so that the voice data packets may contain only a test signal or a combination of a voice signal and a test signal. The test signal can be analysed by the test application in either computer.

As mentioned above, the test application may be used to perform both intrusive or non-intrusive tests. However, depending upon the nature of the test, intrusive tests may be unsuitable for a telephony link which is carrying real-telephony traffic. If a non-intrusive test method is used, then the voice-data packets will only contain voice signals.

Referring now to Figure 2, there is shown three client terminals 150 and a server computer 300 connected to a packet-based communications network 200. Each of the client terminals 150 takes the form of the computer telephony terminal shown in Figure 1. Each of the client terminals 150 may be connected to the network 200 by a remote connection or by a direct connection. The server computer 300 comprises all the functionality commonly found in server computers, for example storage means to store the information resources which can be requested, a network adaptor to allow communication to and from one or more communication networks and a processor and control software to control the operation of the server and to enable the display of information resources in response to user requests.

The server computer 300 displays an information resource to a client terminal in response to a request from that client terminal, the request comprising location data, or an address, that identifies the information resource that the client terminal wishes to access. For example the server computer may be a World Wide Web

(WWW) server that the client terminals are accessing using a WWW browser such as Netscape Navigator or Microsoft Internet Explorer. The server computer may display information of almost any type, for example, details and specifications of products and/or services that may be purchased through the server (or from the organisation responsible for the server) or technical information regarding the configuration of hardware or software within a personal computer. In many cases, regardless of the completeness and clarity of the information provided by the server computer, the user of the client terminal may find that some of her questions remain unanswered. In such a situation, it may be that the most appropriate course of action would be speak to a help desk operator. It is known for WWW sites to have "Call Me" buttons which, when activated, prompt a help desk operator to place a telephone call to the user of the client terminal using a telephone number which is already held by the organisation responsible for the server or which is entered in response to a prompt from the server computer.

A disadvantage of such "Call Me" functions is that many computer users currently rely on dial-up connections to the WWW that require the use of a telephone line. Thus, unless the client terminal user has a second telephone line it is not possible to simultaneously retain the connection to the server computer and talk to the help desk operator. If the information from the server can not be viewed whilst talking to the help desk operator then much of the value of having the information explained is lost as the operator can not refer the user to certain aspects of the information or various options that can be selected.

If a client terminal makes a request for a conversation with a help desk operator, the server computer forwards the request to a help desk terminal 170, which takes the form of the PC-based computer telephony terminal as shown in Figure 1 and described above. The CT application of the help desk terminal initiates a computer telephony link with the respective client terminal, with the test application sending a series of test signals to assess the quality of the telephony link between the help desk terminal and the client terminal. The test signal may measure delay, frequency shaping, temporal clipping in the communications link. The test signals may also be used to assess speech quality using known perceptual analysis methods (see, for example, EP-B-O 647 375, EP-B-O 776 566 & EP-B-O 776567).

Alternatively the test signal may be a short sample of recorded speech, or speech fragments

If the analysis of the signals indicates that there is sufficient bandwidth to support simultaneous access to the WWW page(s) of interest and a CT link of adequate quality then the CT application of the help desk terminal initiates a CT link with the client terminal such that the help desk operator can engage the client terminal user in conversation whilst both parties are able to view selected WWW page(s). The CT application of both computers may both be able to use a number of different codecs (coders/decoders) and the bandwidth available between the two computers may determine which codec is used. Typically a CT conversation requires approximately 16-20 kbit/s of bandwidth, so with a high-speed PSTN modem, i.e. 56 kbit/s, it should be possible to sustain a CT conversation as well as requesting WWW pages and receiving them in a reasonable time. In addition, the test application in the help desk terminal may interrogate the client terminal to ensure that it has sufficient processing power (i.e. speed of processor and available memory) to be able to support the CT application as well as the other processes which are being run on the client terminal. While this may not be an issue for modern PCs as processor speeds are now approaching 2 GHz, older PCs and other devices used to access the WWW, such as set top boxes, games consoles, personal digital assistants (PDAs), third generation mobile telephones etc., may have problems.

If the test application indicates that there is insufficient bandwidth, or that the client terminal is in some way inadequate to enable a CT conversation to be initiated then the help desk terminal does not initiate a CT conversation. Alternative communication routes may be set up, e.g. prompting for an alternative telephone number to call (either for a different PSTN connection or for a cellular phone) or initiating a lower-bandwidth, interactive communication session e.g. using a chat room, or some form of text messaging.

In the above discussion references are made to either the server or the help desk terminal initiating an action or prompting a response. It should be understood that either of these entities could perform the above actions, either in response to a prompt from the other entity or from the client terminal. Also, the test application

might only reside in the client terminal but could be used to test the quality of the link between the help desk terminal and the client terminal, with the analysis of the data being reported to the help desk terminal. If the server and the help desk function (typically there will be a call centre which comprises many terminals) are being operated by the same organisation then the server and the help desk terminal may be co-located and they may share the same access point to the internet. In this case it may be possible to measure the quality of a CT link between the server and the client terminal and assume that a link between the help desk terminal and the client terminal would be of equivalent quality.

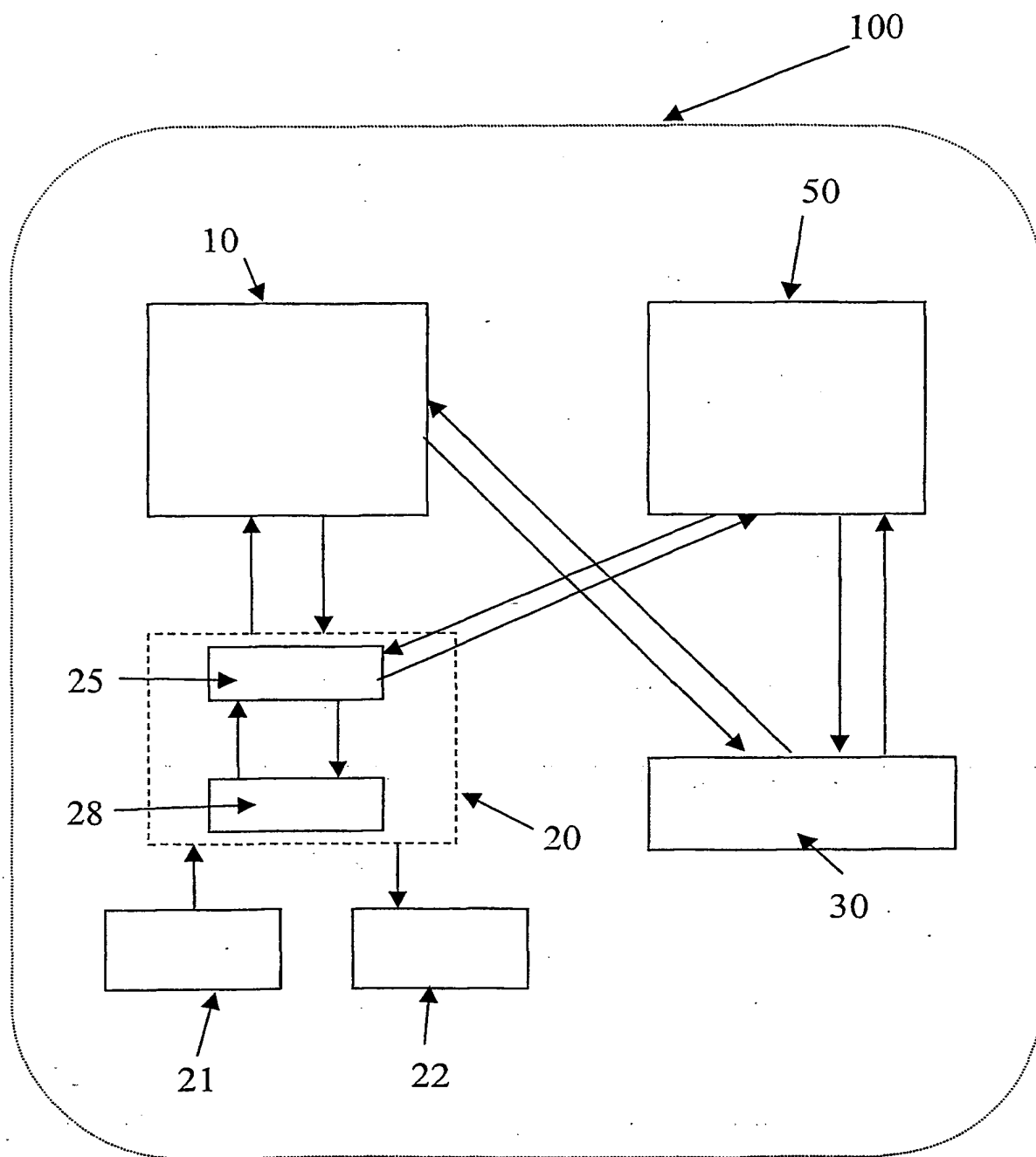
10 It will be readily understood that the principle outlined above may be readily applied to the use of video telephony, as long as both the client terminal and the help desk terminal are equipped with some form of camera, for example a webcam or a video camera/recorder with an interface to a PC, and that the client terminal has a sufficiently fast connection to the WWW such as a cable modem or some form of
15 DSL (digital subscriber loop) connection.

It should be understood that although the above discussion has focused upon the use of a personal computer capable of running both a WWW browser and a computer telephony application, the invention can also be implemented into other devices which can be used to access the WWW, such as set top boxes for the
20 delivery of advanced television services, games consoles, PDAs or similar mobile terminals etc. Software suitable for carrying out the method of the present invention (and thus transforming a suitable PC, or other device, into apparatus according to the present invention) may be supplied on conventional computer media, e.g. floppy disk, CD-ROM, DVD, etc., or over a computer or communications
25 network.

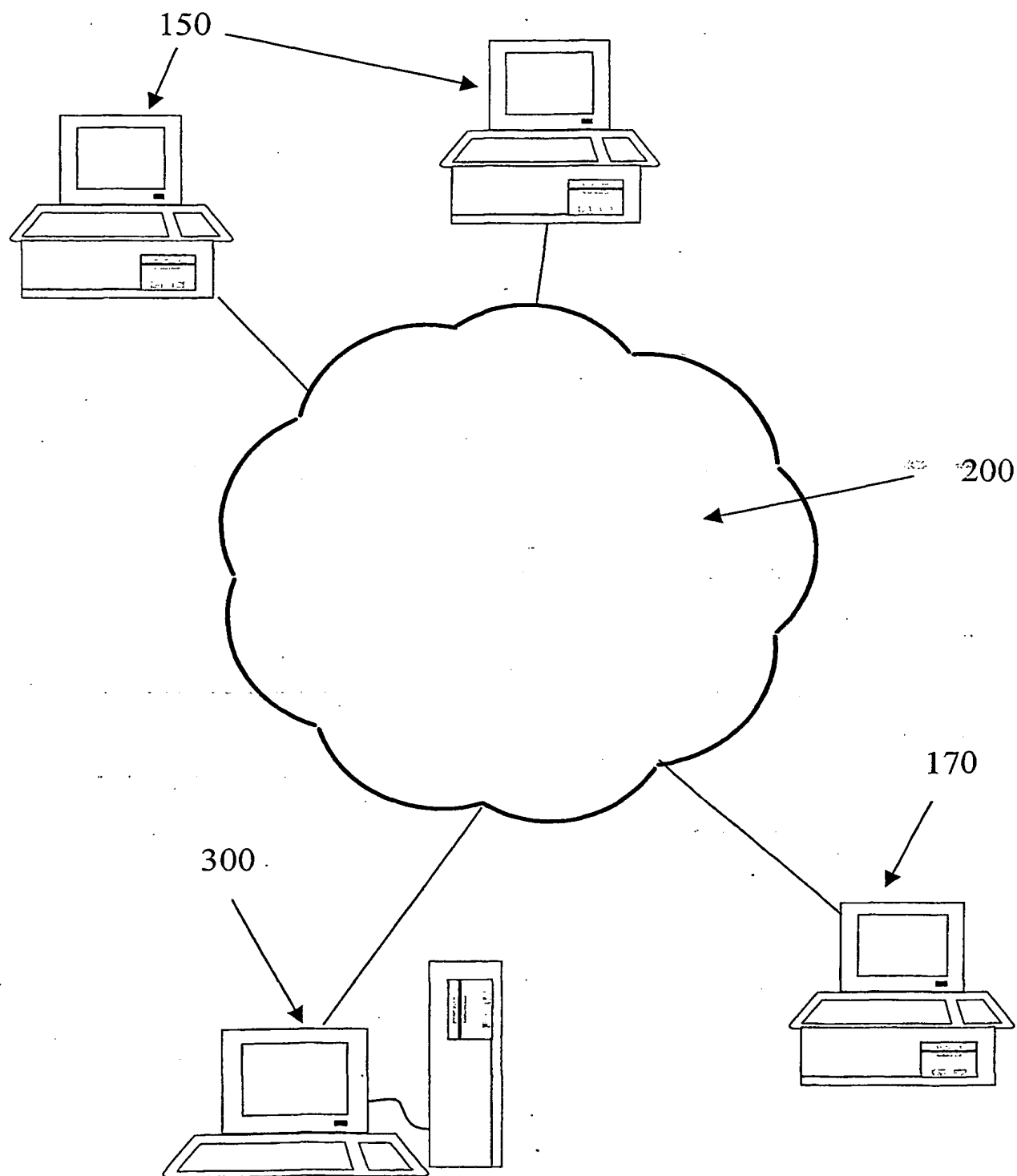
CLAIMS

1. A method of operating a communications network, the communications
5 network comprising one or more network data stores, one or more network terminals
and a plurality of user terminals, the method comprising the steps of:
- (a) establishing a first communications link between a user terminal and a
first network terminal via said communications network;
 - (b) establishing a test link between the user terminal and a second
10 network terminal via said communications network;
 - (c) transmitting a test signal over said test link;
 - (d) measuring the received test signals to determine the capacity of said
test link
 - (e) establishing a communications link between the user terminal and the
15 network terminal via said communications network in accordance with the result of
step (d).
2. A method of operating a communications network according to claim 1
wherein the test link established in step (b) is a computer telephony link between the
20 user terminal and the network terminal.
3. A method of operating a communications network according to claim 1 or
claim 2, wherein the test signal comprises speech or speech fragments.
- 25 4. A method of operating a communications network according to any
preceding claim, wherein the communications link between the user terminal and the
network terminal established in step (e) is a computer telephony link.
5. A data carrier containing computer code for loading into a computer for the
30 performance of the method of any of claims 1 to 4.

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**Figure 1**

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**Figure 2**

INTERNATIONAL SEARCH REPORT

Intern: Application No
PCT/GB 01/02961

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/64 H04M7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MOON Y.S. ET AL: "A CRM Model Based on Voice over IP" 2000 CANADIAN CONFERENCE ON ELECTRICAL AND COMPUTER ENGINEERING. CONFERENCE PROCEEDINGS. NAVIGATING TO A NEW ERA, 7 - 10 March 2000, pages 464-468, XP002154503 Piscataway, NJ, USA, IEEE, USA ISBN: 0-7803-5957-7 abstract page 464, column 1, line 30 -column 2, line 8 page 466, column 1, line 17 - line 42	1,2,4,5
Y	----- -/--	3



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the International filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the International filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

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INTERNATIONAL SEARCH REPORT

 Intern: Application No
 PCT/GB 01/02961

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	MAESHIMA O ET AL: "A METHOD OF SERVICE QUALITY ESTIMATION WITH A NETWORK MEASUREMENT TOOL" IEEE INTERNATIONAL PERFORMANCE, COMPUTING AND COMMUNICATIONS CONFERENCE, US, NEW YORK, NY: IEEE, 10 February 1999 (1999-02-10), pages 201-209, XP000859694 ISBN: 0-7803-5259-9 page 203, column 2, line 27 -page 204, column 2, line 3. figure 4	3
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INTERNATIONAL SEARCH REPORT

Interi pplication No
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